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RADIOLOGICAL SAFETY AT USNRDL

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HEALTH PHYSICS DIVISION
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INTRODUCTION

The operation of the Health Physics Division during the year can be divided into three main programs.

Under Program 1 - Health Physics personnel supported the general Laboratory Operations which included Laboratory consultation and monitoring for the various divisions, dosimetry, radiological services (including waste disposal), environmental surveys, and radiological safety instrumentation.

Under Program 2 - Radiological safety evaluations were made for various segments of the Laboratory, as well as outside agencies. Training in radiological safety regulations and procedures was also supplied under this program.

Under Program 3 - Health Physics personnel participated in support of the Naval Ordnance Testing Station (NOTS) PROJECT 173.

SUMMARY

The operation of the Health Physics Division during the year is divided into three main programs: Health Physics Measures for Laboratory Operations, Radiological Safety Evaluations, and Special Operations.

Program 1.0 - Health Physics Measures for Laboratory Operations

The Health Physics Division continued its regular monitoring services for various scientific divisions of the Laboratory. In 243 routine monitoring surveys of areas occupied by personnel, no significant uncontrolled radiation or contamination levels were observed. Effort expended toward routine monitoring was greatly reduced during the second half of the year because of manpower requirements to support operations at Camp Parks. There were five minor radiological accidents in 1960. In one, personnel radiation exposure averaged about 1.6r (deep dose) and 2.6 rad (surface dose) with a maximum of 2.2r and 3.2 rad. Two minor contamination incidents occurred during the year, neither of which involved personal contamination. In each case the contaminated equipment was successfully decontaminated.

The dosimetry service for the Laboratory, NRDL visitors, and various outside activities was continued. All exposures of NRDL personnel working in Bldg. 815 were below the monthly MPE. At Camp Parks, four exposures in excess of the monthly MPE (1.2r) were detected during the year by the film badge program. These exposures exceeded the allowable limit of 3.0 rem (deep dose) and 6.0 rad (surface dose) for 13 week periods. At Camp Parks the monthly deep dose exposures varied from 0.1 to 4.0r, while the average exposure for the year was 0.43r. The surface dose exposures varied from 0.08 to 6.25 rad, and the average exposure for the year was 0.60 rad. Accountability services for radioactive material and for cyclotron- and reactor-irradiated samples were continued.

The collection and packaging of Laboratory radioactive waste materials was continued during 1960. These materials were collected by licensed commercial firms specializing in the disposal of radioactive wastes. Analysis of the results of the environmental monitoring program indicated that there was no significant release

of radioactive aerosols into the environs by NRDL operations during 1960. The air and water effluent monitoring program was continued on a routine basis.

The radiological safety instrumentation program continued. A request was made for a continuous monitoring system for the liquid waste tank currently in use.

Program 2.0 - Radiological Safety Evaluations

Assistance in the evaluation of special radiological problems was requested of the Laboratory by a number of naval activities, ships, government agencies, and outside organizations. Laboratory assistance given included the monitoring of facilities and specific items for contamination; the evaluation and calibration of instruments; information on shielding problems; rad-safe indoctrination courses; the writing of procedures; the review and criticism of training films and publications; prototype evaluation tests; issuance of publications in the specialized field of radiation and contamination control.

Program 3.0 - Special Operations

Radiological safety support was provided to the Naval Ordnance Test Station (NOTS), China Lake, California, in five weapons' vulnerability tests (Project 173). An evaluation of the contamination potential of the operational suitability test program conducted at NOTS was also made.

Program 1.0 HEALTH PHYSICS MEASURES FOR LABORATORY OPERATIONS

This program is chiefly concerned with the direct health physics support of Laboratory operations. About 92 percent of the available effort was expended on Program 1.0 assignments. The program is divided into five subgroups to facilitate program planning and reporting.

Project 1.10 LABORATORY CONSULTATION AND MONITORING

General

The routine monitoring program was continued during 1960. In 243 monitoring surveys of areas routinely occupied by personnel, no significant uncontrolled radiation or contamination levels were observed. During the last six months of the year the manpower requirements to support operations at Camp Parks greatly reduced the efforts available for routine monitoring.

The annual Laboratory-wide monitoring survey of all NRDL spaces exterior to Bldg. 815 was completed, while the survey within the building was only 60 percent completed. (Monitoring of the basement, second, third, and fifth floors is incomplete.) No significant radiation or contamination has been observed in any Zone 1 area (where radioactive material is not permitted).

Chemical Technology Division

The radiological safety reports for Stoneman II (USNRDL-TR 429) and HYDRA I (USNRDL-TR 483) were distributed.

Preliminary discussions on the rad-safe aspects of the HYDRA II program were held. The rad-safe problems associated with the use of radioactive isotopes in the test pond at Camp Parks were explored. Preliminary shielding requirements and isotope availability were determined in connection with the field phase of HYDRA IIa.

Buildings 510 and 506 have been cleared of field samples. All samples are now being stored in Bldg. 364. Additional cataloguing is required. Plans for future sample handling, including the possible disposal of useless samples, are being made by Chem Tech Division personnel.

All Chem Tech equipment has been removed from Bldg. 506. It is planned to decontaminate or remove all contaminated equipment (ducts, fans, etc.) so that a final clearance may be established prior to returning the building to the jurisdiction of the San Francisco Naval Shipyard. (This will be carried out during the first six months of 1961. The work will be done on a "convenience" basis.)

Rad-safe procedures for handling curie quantities of tritium were prepared and posted in Room 624.

Contaminated equipment being moved to Camp Parks was monitored before and after decontamination. Monitoring support was supplied during the preparation of Pu counting standards from test solutions supplied by the AERE (Atomic Energy Reactor Establishment).

A feasibility study of converting a "camper" type unit or "milk-wagon" truck into a mobile rad-safe center is being made by the Engineering Division of NRDL.

The MTR (Materials Testing Reactor) had advised this Laboratory that only AEC-supported projects will be authorized for irradiation unless commercial irradiation services are not available. A list of alternate irradiation facilities and details on the NRDL irradiation requirements was forwarded to the Logistic Support Division. These agencies were contacted to determine their interest in and capability of handling NRDL's irradiation program.

No decision has been made on a substitute facility for irradiations of the type previously conducted in the MTR. Thirteen inquiries were made; only two affirmative replies were received (General Electric Test Reactor and Westinghouse Test Reactor).

Nucleonics Division

The NRDL south gate range, along the shore line, was posted with radiation signs that can be read several hundred yards away. In addition, large metal signs were posted in the area that specified the source sizes now in use (545c, 92c, and 16c). Discussions were held with personnel assigned to the Shielding Studies Program on the rad-safe aspects of a scatter-free Co^{60} source.

Discussions were held with Nuclear Radiation Shielding Branch personnel on plans and procedures for using a hydraulically-operated Co^{60} source (100c) in the NRDL south gate range. The range is designated as a Zone 4 area and will be used for future work on the Ship Shielding Program. Operating procedures and posting of radiation signs will be effected in accordance with such designation.

Test runs using the traveling Co^{60} source (129c) were made in the NRDL south gate range. Radiation areas were delineated, environmental monitoring films posted, and operating procedures checked out. The 129c Co^{60} source (on loan from Technical Operation Corporation, Massachusetts) will be returned and replaced with a 100c Co^{60} source for future operations in this area.

A 150 mc Co^{60} source being used in Room 488 by Radiological Physics Branch personnel was replaced with a 2 curie Co^{60} source. Radiation levels are less than 5 mr/hr at 2 ft from the shielded source.

A 1 kg Pu-F_4 (760g of Pu^{239}) neutron source fabricated by HAPO (Hanford Atomic Power Operations) was received for the Radiological Physics Branch program. The source was transferred to a special paraffin container and will be used in Room 4129. Rad-safe procedures for routine handling of the source were issued.

A 500 mg Ra-Be source was received from HAPO on 18 October 1960. The source, used for intercomparison of neutron calibrations, was returned to HAPO in mid-November.

Portable shields made of formica and 1/16 in. lead sheets were obtained for use with the Co^{60} (200c) and Cs^{137} (120c) sources in the fourth floor radiac calibration range. These shields reduce the exposure to scattered radiation when the sources are used for extended time periods. The 5 mr/hr line for the Co^{60} source was marked on the floor.

The Cs^{137} (120c) source from the fourth floor radiac range was unloaded in Bldg. 364. An improved mechanism for raising and lowering the source in its UDM-1 container was made. The source was reloaded and returned to use. The difficulties encountered in the source transfer again emphasize the requirement for an adequate facility for the remote manipulation of multicurie gamma sources.

The UDM-1 container (5c Co^{60} source) used in the Bemco weather chamber was removed to the Isotope Storage room. The extreme weathering conditions in the Bemco chamber resulted in faulty operation of the source-moving mechanism, thereby interfering with instrument test and calibration experiments. An improved source-raising mechanism has been designed. The new mechanism will be installed and should eliminate the difficulties in positioning the source.

Consultation and technical assistance were given to the Instrument Branch on the repair of a malfunctioning air-driven Co^{60} source (3c) in a UDM-1 container. The source was unloaded and stored in a shielded container while a new air channel was designed and built. The source has now been re-installed and is again in routine use.

A portable 100 KVP X-ray machine was installed temporarily in Room 480 for use in calibrating a crystal spectrometer. Rad-safe controls for the use of the machine were recommended and the radiation areas associated with the X-ray beam were delineated.

A portable neutron generator (manufactured by the Texas Instrument Co.) was originally installed in Bldg. 815. Rad-safe controls for the use of the generator were recommended. Later, the generator was moved to the south gate range and rad-safe procedures were established for routine operation in this location. During the fourth quarter, arrangements were made for moving the neutron generator to Bldg. 364. Rad-safe requirements were established for the instrument when operating with a tritium target emitting 10^{10} neutrons/sec. Bldg. 365 will be used as a control station and office. Further discussions were held on the requirements for exclusion areas and warning signs and devices in connection with the operation of the neutron generator.

Construction of the Low Background Room was completed. Radiation background control problems were discussed with personnel assigned to operate the counting equipment. The receipt of isotope shipments and the movement of radiation sources in the vicinity of this room will pose serious counting difficulties unless control of ambient backgrounds during counting periods is effective. Background measurements were made during the placement of a 25 mc Co^{60} source at various distances from the Low Background Room, in order to test shielding effectiveness and detector sensitivity.

Monitoring surveys (using portable radiacs and neutron track film) were conducted in the tent and trailer area adjacent to Bldg. 816 to determine neutron levels. It was found that the neutron fluxes in areas where personnel are working were below the MPL.

A 20 mg Ra source was received and is being used in the Radiac Evaluation Program.

Preliminary discussions were held on the rad-safe aspects of the proposed NRDL cyclotron. A visit to LRL (Lawrence Radiation Laboratory) is planned to inspect and discuss the design of rad-chem laboratories for studies of short-life isotopes produced by particle accelerators. This information should be helpful in formulating rad-safe recommendations for the proposed NRDL facility.

Assistance was given to the Dosimeter Research Program in establishing rad-safe control measures for the exposure of film and instruments to a number of neutron sources located in the fourth floor range (Bldg. 815) and in Bldg. 364.

A system for the routine use of self-reading γ dosimeters was established for the fourth floor range. The dosimeters and a log book for recording readings are available to all persons using the range.

Biological and Medical Sciences Division

Routine rad-safe support was provided during the continuation of experiments involving millicurie quantities of HTO, P^{32}, Fe^{59}, I^{131}, C^{14}, Sr^{90}, and H^3 thymidine.

Rad-safe procedures for the operation of the 1 Mev X-ray unit in Bldg. 510 were documented and submitted to the Head of the Bio-Med Division for review.

Rad-safe support was provided during the replacement of a 10 mc Sr^{90} beta plaque in the gas chromotography equipment.

A monitoring survey was made in the animal storage spaces on the fifth floor to determine the radiation levels produced by the 200 curie Co^{60} source (Radiac Calibration Range on the fourth floor) when it is beamed through the east wall of Bldg. 815. The maximum level observed was 1 mr/hr. The radiation levels in the other rooms varied between 0.2 and 0.5 mr/hr depending on the relative distance from the source.

Two new projects were started using tritium gas in animal exposure studies to determine acute and long-term biological effects of gaseous tritium as the result of surface and internal contamination. Rad-safe consultation was provided in connection with the experiments. The equipment to be used has been set up; it was designed to control any gas leakage out of the animal-exposure chamber. Contamination control will be maintained by continuous monitoring with the T-289 tritium sniffer and routine wipe tests. The air in the secondary confining box will be continuously circulated through a tritium detector. In the event that a predetermined concentration of tritium is detected, the air will be circulated through a purging system (heated copper oxide-dehydrator system). The experiments are scheduled to begin early in 1961.

Contact was made with ORNL (Oak Ridge National Laboratory) to determine the availability of Fe^{59} with a specific activity of more than 20 c/g and Ca^{46} with a minimum amount of Ca^{44}.

Rad-safe services were supplied during the use of the several X-ray machines at NRDL and the 60 inch cyclotron at the University of California. These machines were used to study the effects of radiation on various animals (sheep, goats, burros, mice, rats, and rabbits). In one program, small animals were also injected with radioactive tritium to study leucocyte kinetics. This requires the radiography of selected tissues from sacrificed animals.

The UC cyclotron is scheduled for dismantling; hence, the available irradiation time has been decreased. Inquiries have been made regarding the availability of irradiation services at other installations. No substitute has been found.

Technical Services Department

General

Twenty-eight special work permits were issued during the year. The work involved general maintenance of the Isotope Storage room, hood decontamination and filter changing, clean-up of a glove box, decontamination of lead containers and rat cages, and vacuum pump maintenance. The amount of contamination involved was minor and no significant rad-safe problems were encountered. Bldg. 529 was decontaminated and a final clearance was issued.

Rad-safe assistance was provided during the removal of hoods, sinks, and fans from Bldg. 506; these surplus items will be delivered to Port Hueneme. Some decontamination was required to achieve final clearance levels. One item (a fan) was released under standard clearance status. Assistance was provided to the Central Instruments Branch for modification of the Co^{60} calibration range and radiac calibration.

The Co^{60} source in Room 2175 was recalibrated and found to be 2.66 curies in February 1960. The source was replaced with a 12 curie Co^{60} source. After placing several 2 inch lead bricks around the container, no significant radiation levels were observed in any of the adjacent rooms. The highest daily dose observed (using film dosimeters) was 8 mr/day.

An 80 g Pu-Be neutron source was obtained for the Central Instruments Branch instrument calibration work. Additional shielding was placed around the source container to prevent interference with low-level measurements using the Co^{60} source.

Camp Parks

SIMULANT PREPARATION

During the first quarter, eleven spot air samples were taken in the hot cell (Bldg. 131). In addition, two continuously operating cyclic air samplers (30-min. collection cycle) were used. All air samples collected when work was done inside the hot cell or when the mixers were in operation indicated airborne radioactivity. The maximum concentration detected was 1×10^{-5} μc/cc. The average concentration of the 11 spot air samples was 3×10^{-6} μc/cc. (The 1 hour MPC for Ba^{140} is 2×10^{-6} μc/cc.) The sources of the aerosol may have been the hot cell ventilation system, the contaminant transfer system, or the mixing operations. Since the operation is continuous, the contribution from each source is not known. The hot cell ventilation system was redesigned to control the release of aerosols. A more effective blower-filter system was installed. A new transfer system using double-wall tygon tubing was also installed.

During the second quarter, approval was received from the AOO of the Atomic Energy Commission to receive additional 2,000 curie shipments of Ba-La from LASL. Once a week the 2,000 curies is "milked" of 20 to 30 curies of La^{140}. The La^{140} is then used as a tracer for the fallout simulant.

Fencing has been installed around Bldg. 131 (containing the hot cell). A second hot cell, which is a duplicate of the first cell, has been built.

A study was also made of the mixing operation to determine if the mixers or mixing platform require an enclosure and exhaust ventilation.

Air sampling during mixing operations indicated the following average concentrations:

At mixer exhaust: 3×10^{-9} μc/cc
(8×10^{-9} to 1×10^{-11} μc/cc)

75 ft. downwind:	7×10^{-11} μc/cc (3×10^{-10} to 2×10^{-12} μc/cc)
Bldg. 131 roof:	2×10^{-11} μc/cc (3×10^{-11} to 9×10^{-12} μc/cc)

During mixer clean-up operations, the following concentrations were observed:

Inside the hot cell:	3×10^{-7} to 5×10^{-10} μc/cc
On mixing platform:	3×10^{-5} μc/cc
At the fence (75 ft. East of platform):	9×10^{-10} μc/cc

(The 1 hour MPC for La^{140} is 8×10^{-6} μc/cc).

On the basis of data that have been collected, the only area of significant aerosol concentration is within a 20 to 30 ft. radius from the mixer. (The new filter arrangement developed for the two hot cells solved the problem of aerosol release from the confines of the hot cells themselves.) The study of aerosol generation and dispersal during mixing operations is continuing.

Radiation levels in and about Bldg. 131 were considerably dependent on the operations in progress. With a new shipment of Ba-La (approximately 1,000c) in the hot cell and no mixing operations in progress, radiation levels were:

At the fence:	< 2 mr/hr
At platform edge:	5 mr/hr (maximum)
Rear of hot cell:	1 - 4 r/hr
General level (in front of hot cell):	5 - 10 mr/hr
General level (Bldg. 131): (Bldg. 131):	1 - 3 mr/hr

With mixing operations in progress, the radiation levels observed were:

At the fence:	25 mr/hr (maximum)
At platform edge:	200 mr/hr
At mixer:	5 - 10 r/hr

It was found that during the clean-up operations in the hot cell as much as 13 curies of Ba-La had to be removed. Concrete storage containers were made to safely handle and store the waste. Each container was made by pouring a 38 inch cube with a 20 inch hole in the center. This effective shielding thickness (9 inches) reduced the radiation level by about an order of magnitude. Concrete lids with lifting eyes were made to cover the containers after they were filled. A lifting pallet was placed under the container so that it could be easily moved by a fork lift.

During the third quarter, two shipments of Ba-La totaling 3,500 curies were received. Five hundred curies of Ba^{140} (no La^{140} present) were processed on to 5,000 lb. of graded silica sand (150 to 300 μ particle size) in 32 hours of continuous operation. The material was handled in ten batches of 500 lb. each. Each batch was tagged with 50c of Ba^{140} and stored in Bldg. 170 to allow an equilibrium of Ba-La to grow in. This material was used as a simulant for the target complex studies. Typical radiation levels observed were:

Surface of loaded mixer (50c of Ba^{140}):	8 r/hr
Surface of empty mixer (residual mix inside):	3 r/hr
Surface of empty mixer (after La^{140} grew in):	25 r/hr
General radiation level on platform:	100 mr/hr
Inside bldg. (near hot cell):	20 mr/hr
Window of hot cell:	30 mr/hr.

The maximum exposure during the operation was 1.6r, the minimum was 0.17r, and the average exposure was 1.05r. The maximum aerosol concentration observed was 7×10^{-9} μc/cc, the minimum was 5×10^{-10} μc/cc, and the average was 8×10^{-10} μc/cc. (The 40 hour MPC for Ba^{140} is 4×10^{-8} μc/cc.)

Dosage control was achieved by:

1. Use of Ba^{140} (no La^{140} present),
2. 12 inch concrete shadow-shields,
3. Ropes and remotely operated equipment to move batch quantities of contaminated sand.

Aerosol concentrations were minimized by the new, high volume, ultra-filter system attached to each mixer. Two contaminated "milking apparatus" were taken to the waste disposal pit. The pit entrance was enlarged to provide access for a 2-1/2 ton dump truck. A dirt berm was built around the edge of the pit to reduce the radiation levels at the fence to less than 5 mr/hr. A total of 50c was transferred to the waste dump area.

During the fourth quarter, one shipment of 900 curies of Ba^{140} was received. The Ba^{140} is a source of supply for the La^{140} which is used to tag "sea water simulant" (wet fallout studies) and sand (dry fallout and surface decontamination studies).

TARGET COMPLEX STUDIES

The target complex studies were designated as FO-32. During the first quarter, rad-safe support was provided to the Chemical Technology Division during engineering-scale studies on decontamination. The target complex, consisting of buildings, paved and unpaved areas, and foliage, was contaminated with synthetic fallout. The synthetic fallout consisted of 300 pounds of sand (200-300 μ particle size) tagged with 150 curies of Ba^{140}-La^{140}.

During the second quarter, the second target complex study was conducted. Tests of contaminant removal from paved areas were made. Five hundred pounds of sand was tagged with about 20c of La^{140}. The sand was transferred to a mobile hopper and stored near Bldg. 781 in an enclosed (roped-off) area. The radiation level at the hopper surface averaged about 20 r/hr and 2 r/hr at 10 ft. Batches weighing 100 pounds each were then put into a fertilizer spreader and moved to the paved area near Bldg. 533.

The radiation level from a loaded spreader ranged between 100 and 200 mr/hr at 3 ft. Areas measuring 200 sq. ft. were contaminated with the material in the fertilizer spreader. About four or five such areas can be contaminated from one spreader load. A typical concentration at the time of spreading is 200 μc/g of sand. Typical radiation levels over a contaminated area ranged from 50 to 200 mr/hr at 3 ft. and 200 to 1,000 mr/hr at contact. Radiation measurements were made and the contaminant removed with a manually-operated street sweeper. A typical radiation level after sweeping operations was $<$ 1 mr/hr at contact.

The third target complex study (FO-32) was completed during the fourth quarter. Rad-safe support similar to that given to the two previous target complex studies was provided.

Typical radiation levels observed were:

Hand spreader at contact:	2 r/hr
Handlebar of hand spreader:	0.2 r/hr
Unshielded side of truck bed:	1 r/hr
Cab of truck spreader:	0.15 r/hr
Hopper of truck spreader:	3 r/hr
Average level in contaminated target complex:	0.1 r/hr.

The maximum exposure during the target complex study was 1.7r, the minimum 0.2r. The average exposure of the 50 persons involved was 0.80r.

A total of 72 air samples were taken during the operation. The highest aerosol concentration observed (7×10^{-9} μc/cc) was from the dust created by the mechanical street sweeper (dry). (The 40 hour MPC for Ba^{140} is 4×10^{-8} μc/cc.) Only a minimal problem existed, since the dust was quickly dissipated. The average maximum and minimum concentrations observed were as follows:

		Concentration ($\times 10^{11}$ μc/cc)		
Location	No.	Avg.	Max.	Min.
Inner perimeter	62	6	50	0.04
Spot samples	10	120	700	3

A report summarizing the significant rad-safe aspects of the three target complex operations is in preparation. A rough draft should be completed early in 1961.

SURFACE DECONTAMINATION STUDIES

Paved area decontamination studies were conducted during the fourth quarter. La^{140} tagged-sand was spread over concrete-slab surfaces and removed by a mechanical street sweeper. The average radiation levels were 100 to 150 mr/hr, resulting in an exposure of about 250 mr/month to two or three persons. The aerosol concentration observed was less than 10^{-9} μ/cc. There were no significant rad-safe problems.

WET FALLOUT STUDIES

During the fourth quarter, a preliminary test, using 200 mc of La^{140}, was performed at the north end of Bldg. 880. A large plastic sheet surrounded the disperser in order to minimize the spread of the fallout. There were no significant radiation exposures and the rad-safe support was of a routine nature, except for the air monitoring phase. Eight sampling stations were set up in and around the dispersal room. A total of 34 air samples were collected. The aerosol concentrations were as follows: (The 40 hour MPC for La^{140} is 100×10^{-9} μc/cc.)

Location	Date	Aerosol Concentration ($\times 10^{-9}$ μc/cc) Average	Max.	Min.
Decon room	Nov. 23	2	3	0.07
	25	0.02	0.2	0.03
North gym	23	3	5	0.1
	25	0.1	0.2	0.03
	29		0.5*	
Inside gym	23	75	150	0.08
	25		20*	
	29		0.5*	
East door	23	40	60	20
	25	0.30	0.4	0.20
	29		0.8*	
South gym	23	1	2	0.90
	25		0.02*	
Outside bldg.				
East side	23	0.3	0.4	0.20
West side	23	0.2	0.2	0.2
Roof	23	0.3	0.4	0.20
			0.02*	

*Only one sample taken.

ENVIRONMENTAL AIR SAMPLES

A total of 463 environmental air samples was taken on the Camp Parks periphery during the year. The maximum, minimum, and average concentrations observed during each month were as follows

Month	No.	Concentration ($\times 10^{-12}$ $\mu c/cc$) Average	Max.	Min.
January	31	2	20	0.2
February	30	6	20	0.3
March	29	4	30	0.5
April	21	4	30	0.4
May	20	2	40	0.5
June	23	5	20	0.5
July	66	11	80	0.2
August	70	16	330	0.3
September	51	9	30	0.2
October	39	10	90	0.02
November	52	4	20	0.05
December	45	3	10	0.1

Radiation monitoring surveys numbering 85 were documented. The following areas were monitored:

Area	Radiation Level (mr/hr) Average	Max.	Min.
Waste area	125	1,800	B.G. (0.1)
Test area	50	500	B.G.
Equipment storage area	325	11,200	B.G.
Simulant preparation area	700	20,000	0.2
Simulant storage area (Bldg. perimeter)	20	100	B.G.
Target complex	110	725	B.G.
Bldg. 131 area (Hot cell)	870	20,000	B.G.

During the first quarter, wipes, equipment monitoring, and area film badges indicated that the particulate matter from either the hot cell or the target comples area reached the school building at Camp Parks. Air samples taken at the school indicated an average concentration of 2×10^{-11} μc/cc. The maximum exposure of spots on the area film was estimated at 4 rad. The film had been exposed to the contamination for about 22 days. Detailed monitoring surveys indicated no contamination in Bldg. 730 or in personal cars. Continued checks during the balance of the year failed to disclose any repetition of the above measurements.

PERSONNEL EXPOSURES

Personnel exposures for the year are summarized as follows:

Month	Number of Measurable Exposures (<40 mr)	Average Deep Dose (r)	Average Surface Dose (rad)	Maximum Deep Dose (r)	Maximum Surface Dose (rad)
Jan.	7	0.12	0.20	0.27	0.43
Feb.	9	0.12	0.12	0.47	0.47
Mar.	37	0.83	1.36	2.50	3.90
April	18	0.29	0.45	1.00	2.60
May	18	0.42	0.95	2.40	4.40
June	21	0.80	1.31	2.85	6.25
July	24	0.85	1.20	4.00	5.10
Aug.	22	0.36	0.53	1.60	1.85
Sept.	35	0.54	0.70	1.64	2.30
Oct.	80	0.53	0.10	1.70	0.32
Nov.	14	0.11	0.08	0.22	0.12
Dec.	9	0.22	0.17	0.35	0.20

Accidents

Five minor radiological accidents and two minor spills occurred during the year.

On 18 February 1960, the tritium air sample alarm sounded in Room 624. Investigation showed that the tritium release (3×10^{-5} μc/cc for less than a half hour) occurred when some contaminated glassware was discarded into the waste drum (1 hour MPC for H^3 is 8 x 10^{-4} μc/cc). Urine samples of workers indicated no significant internal contamination. Items contaminated with tritium are now being packaged before discard into the waste cans.

On 28 February 1960, a shipping container from LASL (Los Alamos Scientific Laboratory) containing kilo-curie quantities of Ba^{140} was opened in the hot cell at Camp Parks for dissolving and subsequent addition of the solution to sand for tracer tagging. Upon addition of water to the isotope cup to start dissolving operations, aerosol activity was observed in the warehouse building containing the hot cell. As the work continued, aerosol activities up to 10^{-5} μc/cc were observed. Respiratory protection became necessary for all personnel in the warehouse during dissolving operations. One batch of sand was tagged and the work was temporarily discontinued. On 2 March, work was resumed. Upon addition of more water to the isotope cup, a visible cloud of dust was seen to rise from the isotope container. The warehouse was immediately evacuated. The maximum airborne activity (2 x 10^{-5} μc/cc) was observed within the first hour, reducing to 1 x 10^{-8} μc/cc in about 4 hours and eventually dropping to 1 x 10^{-9} μc/cc by the end of the day.

Later in the day, workers re-entered the warehouse to perform a mixing operation. Another increase in airborne activity occurred when levels rose temporarily to 10^{-5} μc/cc. (The MPC for a 10 minute exposure is 10^{-5} μc/cc.) Because of this increase in aerosol activity, respiratory protection was mandatory for all subsequent operations, including dissolving, transferring, and mixing. Respirator cannisters measured up to 20 mr/hr after this operation. The source of aerosol appeared to be a combination of mixing and hot cell operations. Inspection of the blower-filter system disclosed two basic faults: (1) the blower motor was not operating at full efficiency because of mechanical difficulties; (2) the filter had been installed on the pressure side of the blower. Any leakage tended to be out of the system rather than into it.

Urine samples were submitted by all personnel involved. A positive indication of internal contamination was shown although it is estimated that one tenth of the MPBB was not exceeded. (The MPBB for Ba^{140} is 4 μc.) Radiation exposures for personnel engaged in the hot cell operations averaged about 1.6r (deep dose) and 2.6 rad (surface dose) with a maximum of 2.2r and 3.2 rad. Personnel contamination varied from background to 2 mr/hr (OW). Contamination levels in the warehouse averaged about 10 mr/hr (OW) with wipes ranging from 15 c/m per 12 in.^{2} to 3 x 10^5 c/m per 12 in.^{2}

Recommendations were made for improving the ventilation system of the hot cell and the mixing platform, and for installing new transfer lines.

On 2 March 1960, a sedan that had been at Camp Parks was found to be contaminated. Several spots inside the front of the car had radiation levels varying from 4 to 15 mr/hr (OW). After removing the dirt from the car with a modified vacuum cleaner, a standard clearance was issued. Remonitoring of the car on 17 March indicated no detectable contamination.

On 11 March 1960, an instrument mechanic (Code 243) observed an above-warning-level count on the hand and shoe counter. He reported immediately to the Health Physics Division. Monitoring surveys indicated hand contamination to 10,000 c/m and clothing contamination to 20,000 c/m. Skin decontamination procedures were effective in reducing the hand contamination to final clearance levels. The clothing was held for decay of the contamination. No detectable activity was found in a 24 hour urine sample. It was determined that the mechanic had been repairing some radiacs that had been used at Camp Parks. Contamination levels up to 10 mr/hr (OW) were observed on the outside surfaces of three radiacs. The instruments were easily decontaminated to final clearance levels. Code 250 (Transportation and Receiving, in particular) has been requested to notify the Rad-Safe Branch whenever any equipment is returned from Camp Parks.

During the decontamination of a glove box in Room 667 on 24 June 1960, low-level plutonium contamination of four people and the work area was observed. Contamination levels in the work area ranged from 700 to 7,000 d/m (α) per 60 cm^2. Personnel contamination ranged from 150 to 3,500 d/m (α) per 60 cm^2. All detectable activity was immediately isolated and removed. A 24 hour urine sample was obtained from the individual with the most external contamination. Since no internal contamination was detected, it was considered unnecessary to sample the other people involved. The contamination release resulted from insufficient control measures prior to and during the decontamination operation.

Spills

On 16 April 1960, a liquid waste drum stored in the 707 area containing waste water from the decontamination laundry was found to be leaking. The leak was apparently due to a defective drum. The waste was transferred to another drum with no difficulty.

On 25 August 1960, a minor spill involving μc amounts of W^{181} occurred in Room 480. A test tube containing the W^{181} in dry powder form was broken during its removal from a storage cave. The maximum amount of loose activity, as measured by a wipe test, was 61,000 d/m per 100 cm^2. The cave was decontaminated and the broken source disposed of as radioactive waste. No personnel contamination was observed. Recommendations were made to the personnel involved concerning proper construction, storage, and handling of sealed sources used as instrument standards.

Project 1.20 DOSIMETRY

Film was processed for NRDL and outside activities as follows:

NRDL	Film Processed	
Laboratory personnel	7,684	
Laboratory visitors	1,619	
Environmental monitoring	471	
Calibration film	900	
Special films for Nucleonics Div.	109	
Special films for Bio-Med Div.	5	
Special films for Health Physics Div.	3	
RadCon Team film (controls)	11	
Special test exposures	163	
Camp Parks		
Personnel and visitors	1,361	
Environmental monitoring	362	
	12,688	Subtotal
Outside Activities		
San Francisco Naval Shipyard	889	
Treasure Island		
Inspector of Navy Material	523	
Radiac Maintenance School and Dispensary	2,122	
Port Chicago	958	
NAS Moffett Field	97	
USN Dispensary, 50 Fell St., San Francisco	56	
DPWO, 12ND	30	
NSC, Oakland	200	
USS HANCOCK	51	
NAS Fallon, Nevada	67	
USNH, Oakland	21	
MSTS, San Francisco	24	
NAD, Hawthorne, Nevada	17	
U.S. Coast Guard	5	
	5,060	Subtotal
	17,748	Grand total

All exposures of NRDL personnel working in Bldg. 815 were below the monthly MPE.

There were 294 exposures which were associated with the experimental program conducted at Camp Parks. The monthly deep dose exposures varied from 0.1 to 4.0 r; the average exposure for the year was 0.43 r. The surface dose exposures varied from 0.08 to 6.25 rad; the average exposure for the year was 0.60 rad.

Four exposures in excess of the MPE were detected during the year by the Camp Parks film badge program for NRDL personnel and visitors. These four persons, from the Technical Developments Branch, exceeded the allowable limit of 3.0 rem (deep dose) and 6.0 rad (surface dose) for 13-week periods.

	April - June		Calendar Year 1960	
	Deep Dose (r)	Surface Dose (rad)	Deep Dose (r)	Surface Dose (rad)
(1)	3.09	7.29	7.14	14.14
(2)	3.40	6.80	6.73	13.19
	July - Sept.			
(3)	4.22	5.71	4.62	6.41
(4)	3.38	4.38	4.37	5.77

The above exposures resulted from persons working inside the hot cell to disassemble and remove Ba-La "milking apparatus," repairing equipment inside the hot cell, and working in the test area (transporting and spreading fallout simulant tagged with La^{140}).

Malfunctions in the hot cell apparatus made it necessary for persons to go into high radiation areas in order to make repairs. This type of operation resulted in exposures in excess of the quarterly MPE (maximum permissible exposure). Precautions have been taken to minimize this problem by performing a more thorough checkout of hot cell equipment and operation before introducing the radioactive material. These overexposures were reported to the Atomic Energy Commission via BuMed and BuShips.

In addition to the film supplied by NRDL, some film badge monitoring was done by a commercial film monitoring service on a contract basis. The service provided was for neutron dosimetry and finger rings for beta-gamma exposure. Neutron badges numbering

413 (8 of which were environmental) were exposed during the year. The maximum monthly dose indicated was 200 m rem (450 m rem-environmental). Evaluation of 98 finger badge exposures was made. The maximum exposure for a four-week period was 640 mr.

Recent changes in 10 CFR 20 limit the MPE to 1.25 rem/quarter unless previous radiation history is documented. Steps were taken to document the radiation history (prior to NRDL employment) of all NRDL employees. NRDL Notice 5100, dated 14 December 1960, was issued as the first step in obtaining this information.

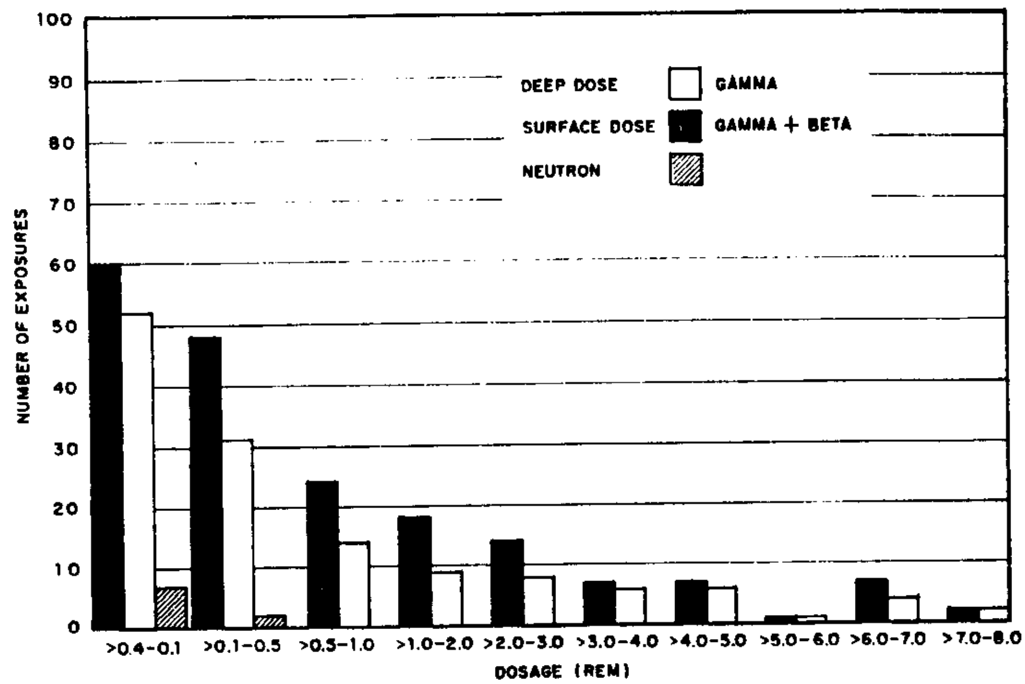
The accompanying bar graph presents the distribution of radiation exposures as indicated by film dosimeters worn by the 591 NRDL employees on board at the end of the calendar year 1960. (Page 23) Personnel terminating prior to the end of the calendar year 1960 are not included in the total. The average annual exposure per person was: deep dose, 247 mr, and 2 m rem (neutron) surface dose, 394 mrad. The maximum deep dose for the year was 7.1r and the maximum surface exposure for the year was 14.1 rad. Both exposures resulted from operations at Camp Parks.

Bio-Assay Program

The following table summarizes the bio-assay results received from the Radiological Health Division during the year.

Division	Number of Samples: Gross $\beta - \gamma$ Analysis	Number of Samples: Specific isotopes	Results
Chem Tech	60	75 H^3	NSA*
		72 Ba^{140}	NSA to 0.11 $\mu c/l$
Bio-Med	71	1 H^3	NSA
Nucleonics	34	-	NSA
MED	22	1 Pu	NSA
Engineering	22	14 Ba^{140}	NSA
		2 H^3	NSA
Admin. Dept.	15	2 H^3	NSA
		1 Pu	NSA
Logistic Support	7	-	NSA
Tech Info	18	-	NSA
Health Physics	6	10 Ba^{140}	NSA
		33 H^3	NSA
		1 Pu	NSA

(continued)



Distribution of Film Badge Totals, NRDL, 1960

Division	Number of Samples Gross $\beta - \gamma$ Analysis	Specific Isotopes	(continued) Results
Comptroller and Management Engineer	4	-	NSA
Program Officer	9	-	NSA
Naval Reserve Personnel	33	-	NSA
Scientific Dept. Staff	4	-	NSA
USCBBU Personnel	-	32 Ba^{140}	NSA
CO and Staff	4	-	NSA
AEC Visitors	2	-	NSA

*Indicates no significant activity.

Project 1.30 RADIOLOGICAL SERVICES FOR LABORATORY OPERATION

Accountability

The following table summarizes the radioisotope orders processed and shipments received for each division during the year.

Division	Orders Processed	Shipments Received
Chem Tech	20 orders - 2,165 mc	77 shipments - 2,796 mc
Bio-Med	25 orders - 1,533 mc	72 shipments - 1,815 mc
Nucleonics	7 orders - 225 mc	20 shipments - 1,415 mc
Health Physics	- -	4 shipments - 54 mc
Totals	52 orders - 3,923 mc	173 shipments - 6,080 mc

Thirteen reactor- and five cyclotron-irradiated samples with an undetermined quantity of radioactivity were received by the Chem Tech Division during the year.

In addition, the following multicurie quantities were ordered or received during the year:

Division	Ordered	Received
Chem Tech	75c H^3	80c H^3
	4400c Ba^{140}	4400c Ba^{140}
Bio-Med	16c H^3	16c H^3
Nucleonics	1.5c Co^{60}	7c Co^{60}
	760g $Pu\text{-}F_4$	760g $Pu\text{-}F_4$
	160g Pu-Be	160g Pu-Be
	2c H^3-Ti	2c H^3-Ti
		1.2c H^3-Zr
Engineering	10c Co^{60}	12c Co^{60}

Under license SNM-35, 527 mg of Pu^{239} and 49 mg of U^{233} were received.

The following table summarizes the radioactive sources currently available in the Laboratory:

Isotope	Number	Total Quantity
Co^{60}	50	1,450 curies (0.32 mc to 698c)
Cs^{137}	6	450 curies (1 mc to 200c)
Ra	12	1,139 mg (0.1 to 500 mg)
Ir^{192}	1	9 mc
Sr^{90}	46	3.3 curies (1 mc to 2c)
Ra-Be	5	138 mg Ra (2 to 100 mg)
Pu-Be	3	162 g Pu (2 to 80 g)
$Pu\text{-}F_4$	1	760 g Pu
H^3	6	4.9 curies H^3 (150 mc to 2.6c)
H^3-Ti	6	9.2 curies H^3 (1 to 5c)

Waste Disposal

During the first six months of 1960 no disposal was made of radioactive waste. However, collection and packaging of Laboratory wastes continued and packages were stored in the 707 area, awaiting later disposal.

Liquid waste totaling 1,500 gal. was removed from the tanks behind Bldg. 364 by the Nuclear Engineering Corporation (a licensed waste disposal firm). The radioactivity concentration was 3×10^{-3} μc/cc, resulting in a total of 17 mc of activity. The waste was transported in a tank truck. Radiation levels at the tank surface averaged 5 mr/hr with a maximum of 25 mr/hr at the drain valve. No spillage occurred during the transfer.

A total of 148 drums and one concrete block containing solid waste were prepared for sea disposal. The drums were monitored and checked for surface contamination and stenciled to indicate the activity of the contents and the surface radiation level. (The maximum radiation level was 5 mr/hr.) The concrete block (300 ft^3, 12 ton) and 24 drums (55 gal.) were picked up by the Ocean Transport Co. (licensed by the AEC) in December 1960. The total radioactivity in the load was about 75 mc of mixed fission products.

Decontamination Laundry and Protective Equipment Issue

Contaminated Laundry Coats

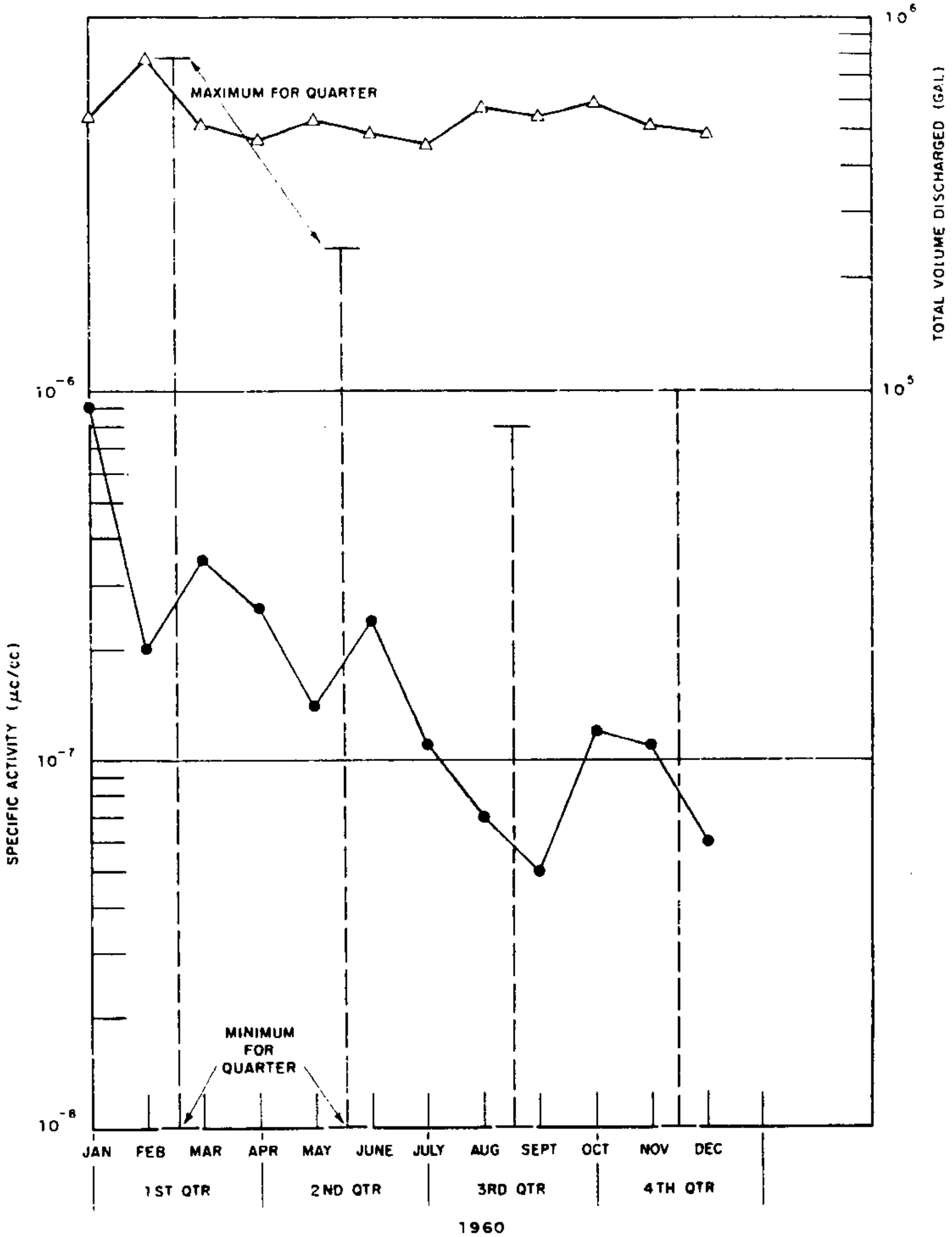
Quarter	$\beta - \gamma$ Contamination Level (c/m)	No. by Division Bio-Med	Chem Tech	Other
1st	3 - 5,000		6	
	3,000	1		
	3,000			1 unknown
2nd	1,500			1 Health Phys.
	1,000		1	
3rd	4 - 7,000		2	
	4 - 7,000	1		
4th	500 d/m alpha		1	

Project 1.40 ENVIRONMENTAL SURVEY

The graph on page 27 gives quarterly averages of the air sampling of outside air and Bldg. 815 air effluent. Environmental aerosol sampling of inside and outside air indicated a continued decrease of long-lived radioactivity since cessation of weapons tests in the fall of 1958. These data are consistent with those reported by other activities. At no time were levels recorded in either system which indicated release of greater-than-MPC's for particulate radioactivity in the environmental air.

Building 815 Air and Water Effluent Monitoring System

The 24 hour sampling and analysis of hood exhaust air for long-lived $\beta - \gamma$ activity continued. The major portion of the samples were in the range of 10^{-13} $\mu c/cc$ (the detection limit is 1×10^{-14} $\mu c/cc$). All samples were well below the MPC's for radioisotopes currently used by the Laboratory. A remote-alarm system was installed and tested. This system records the count-rate observed on the filter paper (during collection) and provides an audio and visible signal in the Rad-Safe Branch Office whenever this count-rate exceeds a preset limit. Fourteen samples collected during the final quarter of the year were below the detection limit of 1×10^{-14} $\mu c/cc$. The calibration of this system for sensitivity of response to various $\beta - \gamma$ energy levels and concentrations has not been completed.



USNRDL Environmental Aerosol Data for 1960

Collection and analysis of water samples from Bldg. 815 liquid effluent collection system continued on a routine basis. A new sample processing system (using a sample volume of 100 cc instead of 1,000 cc) was found to be adequate for the sensitivity and accuracy required. The monthly pooled samples and the pooled tap water samples will continue to be processed in 1,000 cc aliquots.

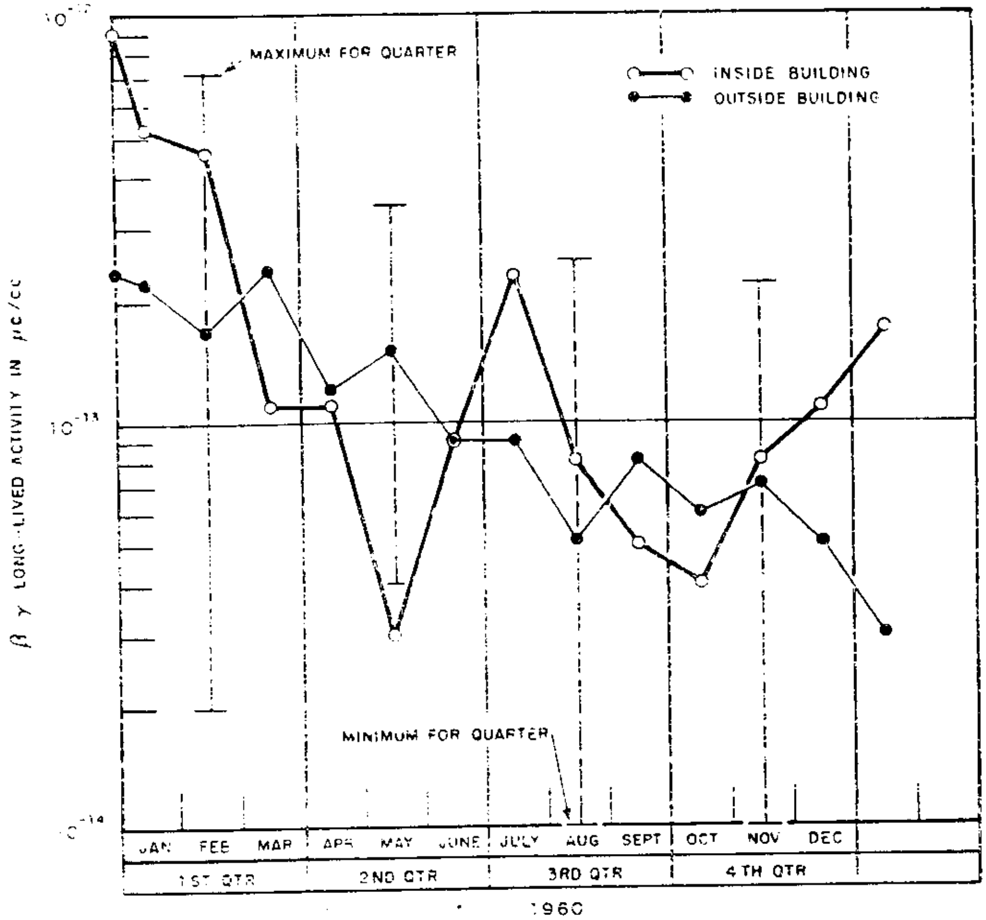
The total volume of liquid discharged per month and the average, maximum, and minimum $\beta - \gamma$ concentrations observed during the year are shown in the following graph. (The concentrations include natural radioactivity and fallout.) (Page 29.)

The average concentration of the liquid effluent discharged during the year was 0.08×10^{-6} $\mu c/cc$. (The MPC is 1×10^{-6} $\mu c/cc$.) The total activity released is calculated to be 0.54 mc. The total volume discharged was 1.5×10^{6} gal. An additional dilution factor is achieved because of water discharged by the SFNS into the same main sewer line. During the year the SFNS discharged 390×10^{6} gal. Therefore, during the calendar year the average concentration of liquid effluent from the SFNS is calculated to be 3.7×10^{-9} $\mu c/cc$.

A 100 cc aliquot was taken from each of the tank samples processed and pooled for each calendar month. The monthly pooled samples were analyzed for Pu^{239} (MPC of 5×10^{-6} $\mu c/cc$) and Sr^{90} (MPC of 1×10^{-7} $\mu c/cc$). Routine pooling of 100 cc/day aliquots of tap water for monthly gross $\beta - \gamma$ analysis was started during the last half of the year. (The average activity of the tap water may be considered as "background".) The results for the year are as follows:

Month	Pu^{239} ($\times 10^{-6}$ $\mu c/cc$)	Sr^{90} ($\times 10^{-7}$ $\mu c/cc$)	Pooled Tank Effluent ($\times 10^{-6}$ $\mu c/cc$)	Pooled Tap Water ($\times 10^{-6}$ $\mu c/cc$)
January	0.07	0.07	-	-
February	0.2	0.09	-	-
March	0.07	0.06	-	-
April	0.04	0.70	-	-
May	0.01	0.3	-	-
June	0.01	0.3	-	-
July	0.01	0.2	0.10	-
August	0.01	0.1	0.08	-
September	NDA*	NDA	0.03	0.01
October	0.03	NDA	0.06	NDA
November	0.01	0.07	0.05	0.02
December	0.01	0.6	0.3	0.02

*Indicates no detectable activity.



NRDL Water Effluent Analysis 1960

Radiation Intensity Monitoring

The uncontrolled spaces in Bldg. 815 that were monitored by the use of film, and the average accumulated dose per 24 hours, by quarters, were as follows:

Average Daily Dose (mr/day)

Location	1st Q	2nd Q	3rd Q	4th Q
Room 665 (hood)	5	33	< 1	27
Room 666 (hood)	1	1	< 1	< 1
Room 682 (sink)	-	< 1	< 1	< 1
Room 687 (E wall)	-	< 1	< 1	< 1
Room 595 (door)	3	2	4	2
Room 5153 (W wall)	3	3	19	3
Room 597 (outside wall)	1	1	3	1
Room 591 (E wall)	5	2	4	1
Room 579 (E wall)	20	13	22	10
Room 448 (outside wall)	-	< 1	< 1	< 1
Room 2129 (N wall)	1	< 1	-	-
Room 2117 (E wall)	11	8	-	-
(S wall)	-	3	-	-

(continued)

Average Daily Dose (mr/day) (continued)

Location	1st Q	2nd Q	3rd Q	4th Q
Room 2177	5	-	-	-
Room 2181	2	-	-	-
(S wall)	-	3	-	-
Room 5149				
(N wall)	-	<1	<1	<1
(E wall)	-	<1	<1	<1
(S wall)	-	<1	<1	<1
(W wall)	-	<1	<1	<1
Fourth floor, 2nd increm.				
(N wall)	9	16	117	12
(E wall)	8	8	55	21
(S wall)	8	4	16	9
(W wall)	4	2	7	3
Room 110				
(N wall)	11	1	5	<1
(E wall)	4	<1	<1	<1
(S wall)	7	<1	2	<1
(W wall)	12	<1	3	<1
Room 185 (near operator's bench)	-	<1	<1	<1

The controlled spaces in Bldg. 815 that were monitored, and the average accumulated dose per 24 hours, by quarters, were as follows:

Average Daily Dose (mr/day)

Location	1st Q	2nd Q	3rd Q	4th Q
Room 480				
(N wall)	15	3	3	<1
(E wall)	1	<1	<1	<1
(S wall)	2	1	1	<1
(W wall)	7	1	2	22

(continued)

Average Daily Dose (mr/day) (continued)

Location	1st Q	2nd Q	3rd Q	4th Q
Room 4128				
(N wall)	13	30	19	16
(E wall)	77	269	70	69
(S wall)	8	16	16	7
(W wall)	16	15	13	13
Room 4121				
(N wall)	14	59	92	14
(E wall)	11	23	37	23
(S wall)	7	8	11	10
(W wall)	3	3	5	17
Room 2125				
(N wall)	4	8	-	9
(E wall)	25	46	-	45
(S wall)	5	11	-	12
(W wall)	8	7	-	4
Room 165				
(S "A" frame)	1	3	<1	<1
(N "A" frame)	-	2	1	<1
(E wall)	1	<1	<1	<1
(W wall)	1	<1	<1	<1
Room 187				
(Operator's bench)	3	4	-	-
(Control panel)	-	-	1	4
Room 1109				
(N wall)	188	-	44	36
(E wall)	165	-	88	60
(S wall)	231	-	117	94
(W wall)	60	-	41	34
Bldg. 816				
(Maze)	-	<1	-	-
(Tool board)	-	<1	-	-
(Passageway)	-	-	<1	17

(continued)

Average Daily Dose (mr/day) (continued)

Location	1st Q	2nd Q	3rd Q	4th Q
Room 2129				
(N wall)	-	-	<1	<1
Room 2117				
(E wall)	-	-	4	2
Room 2177				
(S wall)	-	-	3	-
(W wall)	-	-	-	2
Room 2181				
(S wall)	-	-	4	2
Bldg. 510A	-	-	-	1
(Control board-front)	-	-	<1	-
(Control board-side)	-	-	<1	-
(N wall - outside)	-	-	<1	-
(S wall - inside)	-	-	-	<1
(W wall - outside)	-	-	-	<1
(Control panel)	-	-	-	<1
Room 166				
(S wall)	-	-	-	<1
(W wall)	-	-	-	<1
SHIELDING AREA				
Fence				
W of gate	-	-	-	<1
Near trailer	-	-	-	<1
Opposite "snake source"	-	-	-	<1
At shoreline	-	-	-	<1
Shoreline				
Center (west)	-	-	-	54
Opposite "snake source"	-	-	-	2

(continued)

Average Daily Dose (mr/day) (continued)

Location	1st Q	2nd Q	3rd Q	4th Q
Shoreline (continued)				
Center (east)	-	-	-	<1
North end	-	-	-	<1
Shack on berm	-	-	-	3

NEUTRON FILM

		Average Daily Dose (mrem/day)		
Location	1st Q	2nd Q	3rd Q	4th Q
Bldg. 816				
(Instrument control panel)	-	1	<1	-
(Maze)	-	<1	-	-
(Passageway)	-	-	<1	<1
Bldg. 815				
Room 4101 (E wall)	-	-	-	6
Room 4128 (S wall)	-	-	-	<1

Project 1.50 RAD-SAFE INSTRUMENTATION

Two portable tritium monitoring units, T-290, were received on a one-year loan basis from the Bureau of Naval Weapons. One unit will be kept with the Rad-Con Team equipment and the other will be used in the Rad-Safe Branch monitoring program. Later, an additional T-289 tritium monitoring unit was obtained on loan from BuWeps. A total of 25 Bendix self-reading dosimeters (0-5r) and 10 Staplex air samplers were received for use during Camp Parks operations. Two neutron monitoring instruments (1 AN/PDR-47 and 1 AN/PDR-49) were obtained to fill radiac allowance list allotments.

Fifty 0-5r self-reading dosimeters were received. The major portion will be used at Camp Parks. About a dozen of the units did not meet leak-rate specifications and were returned to the manufacturer.

A deep-well crystal counter was assembled for use at Camp Parks. A hand and shoe counter was taken from storage and set up at Camp Parks.

A prototype counting unit for tritium wipes was installed in the counting room of the Health Physics Division.

Additional portable radiacs have been put in various work spaces for use by scientific investigators. A checkout system has been set up for portable radiacs located in the Rad-Safe Branch office. Arrangements have been made with the Central Instruments Branch for routine servicing of all portable radiacs.

A request was made for a continuous waste-tank-monitoring system. The system will indicate the gamma radiation level of the liquid waste while still in the holding tanks. This system will simplify the present tank-monitoring procedure and reduce the number of samples to be processed on a daily basis.

There is no further requirement for the area monitoring system presently installed in Bldg. 510A; therefore, arrangements are being made for the removal of the system. The unit will be serviced and relocated either at Camp Parks or the NRDL south gate range.

Program 2.0 RAD-SAFE EVALUATIONS

This program is chiefly concerned with the evaluation of special radiological problems within the Laboratory and from outside activities. About 6 percent of the total available effort was devoted to these evaluations. This program is divided into two subgroups to facilitate program planning and reporting.

Project 2.1 RADIOLOGICAL EVALUATION AND PROCEDURAL DEVELOPMENT

San Francisco Naval Shipyard - A portable electrometer, Model 37A, manufactured by Electronic Instruments, Ltd., of Surrey, England, was evaluated for the Industrial Hygienist (Code 722). The dose rate indications on the instrument were compared to actual dose rates for a variety of X-ray energies. The electrometer indicated levels that were within 10 percent of the actual value. Dose rates from 0.045 to 15,000 mr/sec (1.65 to 5.4×10^4 r/hr) may be measured.

The packaging of radioactive waste by SFNS was supervised. Radiation levels around the packaged waste were <5 mr/hr. No detectable activity (α, $\beta-\gamma$) was observed on wipe samples taken on the outside of the containers.

A Co^{60} source was calibrated for use in radiography work on the USS RANGER. Source and handling procedures to be used by SFNS production personnel were also prepared.

NSC Oakland - The packaging of radioactive waste into a large concrete block was supervised. Recommendations were also made on methods of solidifying liquid waste so it could be packaged with the solid waste. No significant rad-safe problems were encountered.

Marine Barracks, T.I. - Information on dosimetry problems related to the disaster control teams of the Marines at T.I. was provided.

District Public Works Office - Recommendations were made to CNO concerning the significance of the request of the State of California for the registration of all radioactive and radiation sources.

Service Schools, USNS, San Diego - The shielding for the radiographic-training facility of the Service Schools was evaluated. Concrete thicknesses were determined for shielding 10 and 30 curie Iridium 192 capsules.

USNAAS, Fallon, Nevada - The radiation levels associated with operation of the X-ray units (dental and medical) installed in the NAAS Dispensary were evaluated. Film dosimeters were placed in and about the various work spaces by Station personnel and forwarded to NRDL for processing and evaluation. No significant radiation levels were observed on any of the films submitted.

Two film dosimeters submitted by the Station indicated possible overexposure. In each case, the film dosimeter was worn in a holder different than that specified in 12ND INST 6150.2. This complicated the evaluation and interpretation of the film. In one case, it was determined that the dosimeter holder used had lost a portion of its cadmium absorber. In the other case, attempts were made to duplicate the exposure both at Fallon and NRDL. The exposure was estimated to be 55r of X-ray radiation.

NAD, Hawthorne, Nevada - The radiation shielding integrity and the rad-safe aspects of operating a fluoroscopic unit for inspecting boxed ammunition were determined. No significant radiation levels were detected with a portable radiac. Inspection of film after one hour of exposure at various points on the shielding surrounding the unit failed to disclose any stray radiation beams. It was concluded that the operation of the unit in the present location, in accordance with established operating procedures, would not result in any significant radiation exposure of personnel.

To ensure that proper records are available to document the radiological conditions associated with the use of the unit, it was recommended that:

a. A routine physical examination be made on all potentially exposed personnel.

b. All personnel working in the area wear a film badge. (The badge is to be exchanged monthly.)

c. Film badges be posted in the area around the machine and changed on a monthly basis.

d. A monitoring check be made if it is necessary to dismantle any portion of the existing shield in order to repair the equipment.

USS SCANNER (AGR-5) - A sample of a white powdery substance deposited on electronic equipment aboard the AGR-5 as the result of breaking an electronic tube containing radioactive material was analyzed for radioactivity. (The broken tube contained 0.3μc of Co^{60}.) No radioactivity was detected in the sample submitted for analysis.

USS SALISBURY SOUND (AV-13) - Radiation exposures indicated on film dosimeters issued to personnel of the AV-13 were investigated.

BuShips, Code 362 - The radiological hazards associated with course rings for Navy wrist compasses were evaluated. The course rings contained Promethium 147 encapsulated in ceramic microspheres manufactured by the Minnesota Mining and Manufacturing Company. The course rings did not meet contract specifications for dose rate or degree of removable activity.

The initial evaluation of the radiological hazards associated with Navy deck clocks marked with Pm^{147} was completed. It was determined that the clocks are not a radiation hazard. However, it was not possible to measure the amount of loose contamination resulting from Pm^{147} because of the presence of radium and its decay products. (The two test clocks had previously been marked with radium-bearing luminous markings.) Although the amount of loose contamination was minor, it was recommended that Pm^{147} be applied to new units that are free of any other radioactive contaminant in order to evaluate the contamination problem, if any, from Pm^{147}. The procedures and associated costs for the removal of radium markings from the Navy deck clocks now in use were provided.

BuShips, Code 670 - The scripts for a series of training films on the operation of radiacs and associated monitoring procedures were reviewed. It was recommended that a thorough review of the series be undertaken by BuShips, possibly leading to a complete re-orientation of the entire approach.

BuShips, Code 423 - An AEC publication, "Living with Radiation," was reviewed to determine its usefulness to the Navy. It was recommended that the publication be made available to fire departments and disaster units ashore.

San Francisco HEW Office - A Co^{60} source for use in training Civil Defense personnel of HEW was made available on a temporary basis.

Eastman Kodak - Assistance was given Code 944B in the evaluation of a new type personnel dosimeter packet developed by Eastman Kodak. The film packet is reported to be usable for exposure from 10 mr to over 1,000r. On the basis of the evaluation, this appears to be true. However, there may be some undesirable features at low exposures. Fogging, aging, and natural background apparently can introduce an uncertainty of about 30 mr. Comments were made on film response, packaging, adaptability to the present NRDL film badge, and processing procedures.

Grumman Aircraft, Bethpage, L.I., N.Y. - A review and discussion of health physics problems and organization was conducted with two representatives from Grumman.

Minnesota Mining and Manufacturing Company - The requirement for and the manufacturing problems associated with alpha sources for an alpha monitoring facility were discussed. It was determined that various types of surfaces could be contaminated with either Pu^{239} or Th^{232}. An attempt will be made to produce surfaces with no significant removable contamination.

Diamond Ordnance Fuze Laboratories, Washington, D.C. - The various types of radiacs that could be used at the Diamond Ordnance Fuze "Trigger" type reactor were discussed.

Principles of Radiation and Contamination Control (PORACC) - Volumes II and III of PORACC, after appropriate review and approval by the Bureau of Ships, were printed by the Government Printing Office and forwarded to NRDL for issue during 1960.

Photodosimetry Calibration - Calibration curves for the film emulsion currently being used were prepared using Sr^{90}, Co^{60}, U^{238}, Cs^{137}, and 70, 120, and 180 Kev X rays. The fading characteristics of the DuPont 510 film were observed to be unusually high. Different operating techniques in developing, reading, and exposing were tried and no significant difference was noted. A fading curve has been determined. The film manufacturer indicated that a new film base is being used for the 510 type film. DuPont is checking the possible reasons for the increased fading and will try to reduce this effect. Additional studies are to be made on the use and storage of film badges at Camp Parks. There have been some anomolies observed on film badges that were supposedly exposed under similar conditions.

Radiological Trainer - A conference was held on 25-27 January 1960 at the Naval Training Device Center (NTDC), Port Washington, New York, regarding the radiological trainer. The operating procedure manual was reviewed and the prototype device was inspected. Suggested modifications to the device were made. It was agreed that NRDL participation was desired in the prototype evaluation. A letter requesting a proposal for such participation was received on 30 March 1960. Details of the proposal were discussed with personnel of the Naval Schools Command at Treasure Island who have been charged with evaluating the prototype for BuPers.

On receipt of the prototype unit (Device X11F3), it was necessary to repair minor damages sustained during shipment. Also, minor modifications were made on the spray lance shut-off valve and the design of the lid.

Detailed discussions were held with personnel of the Naval Schools Command, Treasure Island, concerning the evaluation tests. A suggested test program was prepared. A proposal outlining NRDL's requirements for assisting in the prototype evaluation was submitted to NTDC on 15 July 1960.

Following a meeting with Naval Schools Command personnel on 3 October 1960, NRDL submitted recommendations to BuPers on the evaluation of the prototype. Endorsements were also provided by BuMed and BuShips. The necessary funds for NRDL's participation in the prototype evaluation were forwarded to NRDL by NTDC on 15 November 1960. In a letter dated 9 December 1960, BuPers established guidelines for the Naval Schools Command in connection with the evaluation. The evaluation is scheduled to begin early in 1961. Present plans are for some of the work to be done at T.I. and some to be done at Camp Parks. Sample capsules were obtained from

ORNL, and B.E. permit No. 1105 was obtained for the depleted-uranium shipping container. The contract for manufacture of the container is being negotiated.

Alpha Monitoring Facility - A request was received from BuYards and Docks for a proposal for the "preparation of a specification and the procurement and application of the alpha emitter material for an alpha monitoring facility." After additional discussions with BuYards and Docks personnel, a proposal entitled "Facility for Training Alpha Monitors" was submitted on 4 May 1960. The objective of the proposal is: "To prepare specifications for a facility to train alpha monitors and to provide technical direction in the development, manufacture and use of the facility." The funding requirement for FY 1961 was $34, 000. On 30 November 1960, the proposal was resubmitted to BuPers via BuMed and BuShips. On 14 December 1960 a favorable first endorsement was provided by BuMed.

RADCON Program - Procedures for setting up and operating the counting equipment assigned to the RADCON team were prepared. A sample handling procedure to record counting data was also written. A presentation of the rad-safe specialist's mode of operation and the general operating problems foreseen was made to the RADCON team members.

Project 2.2 RAD-SAFE TRAINING

A short rad-safe indoctrination was given to personnel from the Naval Construction Battalion Base Unit of Port Hueneme, California. The C-B's participated in Laboratory operations at Camp Parks.

A 1 hour rad-safe briefing was given to Central Instrument Branch personnel. Free discussion was encouraged and emphasis was placed on contamination control problems.

Three lectures on the subject of Personnel Protection were presented at the Medical Officers' Training Course held at the Naval Schools Command, Treasure Island, during January 1960. About 35 medical officers of the armed forces attended the course.

A topical outline was prepared for a training course in photodosimetry operations. The course is intended for NRDL enlisted personnel.

Consultation was held with a BuShips representative on training films showing the use of radiacs. Several such films are currently being produced in El Centro, California.

No work on this project was scheduled for the last six months of the year.

Program 3.0 SPECIAL OPERATIONS

About 2 percent of the total Health Physics Division effort was expended on Program 3.0. Only one project was active during the first three quarters of the year; no effort was required on the Special Operations program during the final quarter.

Project 3.40 RAD-SAFE SUPPORT FOR NAVAL ORDNANCE TESTING STATION (NOTS), PROJECT 173

The requirements for an α and $\beta - \gamma$ counting system were determined. A lead "counting pig", a 5 inch photomultiplier tube, and two 2 inch end window G-M tubes have been ordered. Drawings for a filter holder and valve assembly were requested from NRL.

An alpha scintillation detector with about 30 percent efficiency for U^{233} alphas was constructed and placed into operation. The system will accept 5 inch diameter samples.

The letter report summarizing the NRDL analysis of the contamination potential of the OST program as conducted at NOTS was completed and forwarded to NOTS on 23 May 1960.

Rad-safe support was provided to NOTS for five weapons vulnerability tests conducted early in 1960. No significant rad-safe problems were encountered. The reports of these tests were issued in June and August.

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